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Misallocation and Establishment Dynamics

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Misallocation and Establishment Dynamics[1]

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Abstract

The gap between marginal revenues and marginal costs of inputs (i.e., distortions or wedges) at establishments potentially lower aggregate total factor productivity (TFP) by preventing efficient allocation of resources among incumbents, deterring entry and exit, and affecting technology choices. We investigate the impacts of distortions on aggregate TFP, entry and exit, and establishment-level productivity growth using a rich dataset of Japanese establishments falling into manufacturing industries. Our main findings are the following. First, if capital and labor were reallocated in Japan to equalize marginal products to the extent observed in the United States, aggregate TFP would increase by 6.2%. Second, the efficient size distribution of establishments that would be realized without any distortions would be more dispersed than the actual one. Third, distortions have a significant impact on entry and exit as well as establishment-level productivity growth. Finally, we investigate the factors of distortions, obtaining evidence that financial constraints result in distortions.

Keywords: Misallocation, Aggregate total factor productivity (TFP), Establishment-size distribution, Establishment dynamics.

JEL classification: O16, E44, E22

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1 Introduction

The gap between marginal revenues and marginal costs (i.e., distortions or wedges), at establishments lower aggregate total factor productivity (TFP) by preventing efficient allocation of resources among incumbents (e.g., Hsieh and Klenow [18] and Restuccia and Rogerson [27]). Furthermore, establishment-level distortions potentially affect entry and exit behaviors by affecting the expected profits from entry (Restuccia and Rogerson [27]). They may also affect establishment-level productivity growth by affecting the technology adoption decision (Midrigan and Xu [21]). The purpose of this paper is to offer new evidences on the effects of establishment-level distortions on aggregate TFP, establishment-size distribution, and entry/exit behaviors using a rich dataset of Japanese establishments falling into manufacturing industries. We further aim at revealing the factors that bring about establishment-level distortions.

To these aims, we first measure establishment-level distortions on capital and output by applying the methodology developed by Hsieh and Klenow [18] (HK, hereafter) to our large-scale, establishment-level dataset of Japanese manufacturers. Then we use the measured distortions to calculate the hypothetical aggregate TFP gains as well as the hypothetical distribution of establishment sizes that would be realized without distortions. The basic idea underlying HK's methodology is to measure distortions in terms of the differences in marginal revenues across establishments, based on the theoretical prediction that without distortions marginal revenues would be equalized. Next, we estimate the effects of distortions on establishment entry and exit and on subsequent establishment-level productivity growth. Finally, we regress distortions on a number of proxies for potential sources of distortions: government regulations, external finance constraints, and labor market frictions under the seniority system.

Our main findings are the followings. First,if capital and labor were reallocated in Japan to equalize marginal products to the extent observed in the United States, aggregate TFP would increase by 6.2%. Second, the efficient size distribution of establishments that would be realized without any distortions would be more dispersed than the actual one. Third, distortions have a significant impact on entry and exit as well as establishment-level productivity growth. Finally, financial constraints result in overall distortions.

This paper contributes to two closely related strands of literature. One is recently emerging literature on the effects of policy-induced distortions on misallocation and resultant TFP losses. Using microdata on manufacturing establishments in China, India, and the United States, Hsieh and Klenow [18] find that if capital and labor were hypothetically reallocated to equalize marginal products to the extent observed in the United Staes, manufacturing TFP would increase by 30%-50% in China and 40% -60% in India. They attribute such misallocation to state ownership in China and licensing and size restriction in India.[1] Restuccia and Rogerson [27]

[1]Baily et al. [4] document that about half of overall productivity growth in US manufacturing in

develop neoclassical growth model that incorporates heterogeneous productivity and producer-specific taxes and subsidies to output or the use of capital or labor. Considering taxes of 30 to 40% (and subsidies so that the net effect on steady-state capital accumulation is zero) that depend positively on establishment-level productivity, they find that the reallocation of resources implied by such policies lead to decrease in output and TFP in the range of 30 to 50%. Bartelsman et al. [3] develop a model in which heterogeneous firms face adjustment frictions (overhead labor and quadi-fixed capital) and idiosyncratic distortions, showing that the model can be calibrated to match the observed cross-country patterns of the within-industry covariance between productivity and size. They also point out an important role of misallocation distortions in firm survival and exit. In measuring establishment-level distortions, we follow the methodology developed by Hsieh and Klenow [18] and analyze their macroeconomic consequences including aggregate TFP losses and establishment entry and exit. Furthermore, unlike Restuccia and Rogerson [27] and Bartelsman et al. [3] we explore factors that yield establishment distortions.

Another strand of literature that is closely related to this paper is the misallocation of credit in Japan during the banking crisis in the 1990s. Caballero et al. [7] investigated 'zombie' lending practices and the resultant misallocation in the 1990s in Japan. They found that firms that were insolvent but kept afloat thanks to unusually low-cost bank loans crowded out solvent firms, resulting in low industry-level productivity in the 1990s when many Japanese banks fell into financial difficulties. [2] Although this paper covers almost three decades from 1981 to 2008, low-cost credit associated with 'zombie' lending in the 1990s would appear as a negative distortion in the measured establishment-level distortion and constitutes a source of misallocation overall in our analysis.

The rest of the paper is composed as follows. In Section 2, we measure establishment-level distortions and estimate the hypothetical TFP gains and the hypothetical establishment-size distributions that would be realized without distortions. We further analyze the effects of distortions on establishment entry and exit. In Section 3, we investigate the factors that result in establishment-level distortions. Our main interest is whether the measured distortions on capital are correlated with a measure of external finance dependence. The hypothesis we test is that a establishment that depends more on external finance is more likely to be bound by borrowing constraints, and hence faces a higher distortion on capital. Finally, Section 4 summarizes the results.

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the 1980s can be attributed to factor reallocation from low productivity to high productivity establishments.

[2] Peek and Rosengren [23] document how poorly-capitalized banks allocated credit inefficiently in the 1990s in Japan.

2 Measurement of Distortions and Resulting Aggregate TFP and Establishment-Size Distribution

In this section, we first describe how we measure establishment-level distortions on capital and output, as well as the effect of such distortions on aggregate productivity and establishment size distribution. Then we apply the methodology to a rich dataset of manufacturers in Japan.

2.1 Model

We follow HK and set up a static, partial equilibrium model of monopolistic competition. There are a representative final good producer, representative industrial good producers, one for each industry, and many differentiated good producers in each industry. The final good producer and the industrial good producers operate in a perfectly competitive market, while differentiated good producers operate in a monopolistic market.

The final good producer combines the output Y_s of industry $s \in \{1, ..., S\}$ and produces output Y using a Cobb-Douglas production technology:

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s}, \quad where \sum_{s=1}^{S} \theta_s = 1. \tag{2.1}$$

Denoting the price of industrial good Y_s by P_s, cost minimization and the competitive market assumption imply

$$P_s Y_s = \theta_s P Y, \tag{2.2}$$

where $P = \prod \left(\frac{P_s}{\theta_s}\right)^{\theta_s}$ represents the final good price and equals the marginal cost. We choose the final good as the numeraire, so that $P = 1$.

Industrial good producer s combines differentiated product $si \in \{1, ..., M_s\}$ to produce industry output Y_s using a constant elasticity of substitution (CES) production technology:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma_s - 1}{\sigma_s}}\right)^{\frac{\sigma_s}{\sigma_s - 1}}, \quad \sigma_s > 1. \tag{2.3}$$

Note that we allow for the elasticity of substitution (σ) to vary across industries. Denoting the price of differentiated good si by P_{si}, cost minimization and the competitive market assumption imply

$$P_{si} = P_s Y_s^{\frac{1}{\sigma}} Y_{si}^{-\frac{1}{\sigma}}. \tag{2.4}$$

σ represents the price elasticity of demand for differentiated good si.

Producer si produces a differentiated good Y_{si} from capital K_{si} and labor L_{si} using a constant returns to scale Cobb-Douglas production technology with idiosyncratic TFP, A_{si},

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}. \tag{2.5}$$

We consider two kinds of distortions that lead marginal revenue to divert from marginal cost. One is output distortion, τ_{Ysi}, while the other is capital distortion, τ_{Ksi}. Alternatively, we could consider labor and capital distortions; however, whichever we choose does not affect our measures of aggregate TFP efficiency (TFPGAIN or TFPGAP) below or the establishment-size distributions that would be realized if we removed distortions.[3] Although τ_Y and τ_K are treated as exogenous parameters in this section, they may in fact be affected by numerous factors, with taxes and subsidies being obvious candidates. For example, τ_Y is likely to be higher for firms on which government imposes strict regulations on production. It is also likely to be higher for firms that are protected from entry of competitors, although such firms voluntarily restrict their output. On the other hand, τ_Y is likely to be lower for firms that, for example, have access to preferential government treatment in special zones (such as export processing zones and special zones with laxer regulations and simplified administrative procedures[4]). Similarly, τ_K is likely to be higher for firms that depend on costly external finance and lower for firms that have better access to credit.

Producer si's objective is to maximize profits subject to demand (2.4) and technology (2.5):

$$\Pi_{si} = (1 - \tau_{Ysi}) P_{si} Y_{si} - w L_{si} - (1 + \tau_{Ksi}) R K_{si}, \tag{2.6}$$

where w is the wage rate and R is the rental cost of capital.

2.2 Measuring Producer-Level Distortions and Productivity

Based on the above setting, we describe how we measure producer-specific distortions from observable data. From producer si's optimal decision and demand function (2.4), we obtain

$$1 + \tau_{Ksi} = \frac{\alpha_s}{1 - \alpha_s} \frac{w L_{si}}{R K_{si}}, \tag{2.7}$$

[3] Suppose alternatively that the producer faces labor distortion τ^*_{Lsi} and capital distortion τ^*_{Ksi}. Then, comparing the first order conditions, we see that $1 - \tau_{Ysi} = \frac{1}{1+\tau^*_{Lsi}}$ and $1 + \tau_{Ksi} = \frac{1+\tau^*_{Ksi}}{1+\tau^*_{Lsi}}$. It could be said that in the case we consider, output and capital distortions are standardized in terms of labor distortions. We can identify only two of the distortions on output, capital and labor, because there are two factors of production and hence two first order conditions on the input decision.

[4] Japan, for instance, enacted the Law on Special Zones for Structural Reform in 2002 and has set up numerous special zones to demonstrate the effects of deregulations.

$$(2.8) \qquad 1-\tau_{Ysi} = \frac{\sigma_s}{\sigma_s - 1}\frac{wL_{si}}{(1-\alpha_s)P_{si}Y_{si}},$$

and

$$(2.9) \qquad A_{si} = \kappa_s \frac{(P_{si}Y_{si})^{\frac{\sigma_s}{\sigma_s-1}}}{K_{si}^{\alpha_s}L_{si}^{1-\alpha_s}}, \quad where\ \kappa_s = (P_s^{\sigma_s}Y_s)^{\frac{-1}{\sigma_s-1}}.$$

We can observe wage compensation wL_{si} and nominal output $P_{si}Y_{si}$ for each producer si. By setting the rental cost R at a plausible value, we can obtain τ_{Ksi} and τ_{Ysi} from (2.7) and (2.8). Although we cannot observe κ_s, this does not affect A_{si} relative to the industry TFP and hence reallocation gains.[5] We therefore set $\kappa_s = 1$. We can then obtain A_{si} from observable nominal output $P_{si}Y_{si}$ using (2.9), even though producer si's price P_{si} and output Y_{si} are not separately observable. To derive Y_{si}, we raise $P_{si}Y_{si}$ to the power of $\frac{\sigma}{\sigma-1}$ based on demand function (2.4). We call A_{si} "physical productivity" or "TFPQ" and distinguish it from "revenue-based productivity" or "TFPR" ($\equiv P_{si}A_{si}$) hereafter following Foster et al. [13] and HK.[6] We obtain producer si's TFPR as follows:

$$(2.10) \qquad TFPR_{si} = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{w}{1-\alpha_s}\right)^{1-\alpha_s}\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}.$$

2.3 Aggregate TFP

Once we have measured producer-level distortions and TFPQ, it is straightforward to derive aggregate TFP. We describe the derivation in Appendix A. The basic idea is the following. (2.10) shows that without distortions, revenue-based productivity (TFPR) would be equalized across producers within an industry even though physical productivity (TFPQ) differs: a more productive producer operates at a larger scale and sells its product at a lower price. To the extent that revenue-based productivity differs across producers, aggregate TFP is lower than the efficient aggregate TFP, which would be achieved without any distortions. Aggregate TFP thus depends on the deviations of $TFPR_{si}$ from its industry-level average for each industry.

We call the ratio of the actual aggregate TFP to the efficient aggregate TFP *TFPGAP*. Specifically, we define TFPGAP as the ratio of actual aggregate output to the efficient aggregate output that would be achieved without output or capital distortions while keeping the industry-level capital and labor at the actual levels. We also report *TFPGAIN*, which measures the gains of TFP from removing all distortions, i.e., $TFPGAIN \equiv \frac{1}{TFPGAP} - 1$.

[5]The industry TFP refers to TFP_s in Appendix A.

[6]Note that $TFPQ_{si} = \frac{Y_{si}}{K_{si}^{\alpha_s}L_{si}^{1-\alpha_s}}$, while $TFPR_{si} = \frac{P_{si}Y_{si}}{K_{si}^{\alpha_s}L_{si}^{1-\alpha_s}}$. With the notable exceptions of Foster et al.[13] and HK, researchers have conventionally used TFPR as a measure of establishment- or firm-level productivity, although TFPR is not adjusted for the idiosyncratic price level.

To quantify the effects of only capital distortions on aggregate TFP, we introduce $TFPGAP_{capital}$ as well, which is the ratio of the actual aggregate output to the aggregate output that would be achieved only without output distortions while keeping the industry-level capital and labor at the actual levels. $TFPGAIN_{capital} \equiv \frac{1}{TFPGAP_{capital}} - 1$ measures how much aggregate TFP would increase if capital distortions were removed.

Let us clarify the concept of TFPGAP (and TFPGAIN) employed here. First, TFPGAP is an efficiency measure relative to the highest TFP achievable without idiosyncratic distortions given the market structure of monopolistic competition. It is not an efficiency measure relative to the highest TFP achievable without any distortions in a competitive market, where the most productive producer would take all the market share.[7] Second, TFPGAP measures the allocation efficiency and as such reflects the variation in, not the average of, distortions across producers. In this regard, the measurement of misallocation contrasts with business cycle accounting (e.g., Chari et al. [8]), which focuses on the fluctuation in the average level of distortions over time. Third, although TFPGAP is measured given the actual allocation of capital and labor across industries, the Cobb-Douglas aggregation across industries (2.1) means that TFPR equalization would not affect the allocation of capital and labor across industries because the rise in an industry's productivity would be exactly offset by a fall in its price index.[8] Finally, TFPGAP is a measure of the allocation efficiency given total resources. A rise in average capital distortions, for example, is likely to reduce capital accumulation and hence output. However, it does not necessarily lead to inefficient allocation for a given total amount of capital.

2.4 Size Distribution

Next, we consider some of the implications that distortions have for the size distribution in terms of output. Producer si's first order conditions yield:

(2.11)
$$log(Y_{si}) = \sigma_s log(1 - \tau_{Ysi}) - \alpha_s \sigma_s log(1 + \tau_{Ksi}) + \sigma_s log(A_{si}) + const,$$

where *const* is a term that does not depend on producer si. (2.11) suggests that distortions affect the size distribution. Specifically, (2.11) suggests that $log(Y_{si})$ is likely to be more dispersed the more dispersed distortions to either output or capital (or both) are, the less positively (or more negatively) distortions to either output or capital are correlated with TFPQ, and the more positively (or the less negatively) distortions to output and capital are correlated with each other. We will show how the size distribution would change if we hypothetically removed capital and output distortions.

[7] Appendix A shows that our measure of efficient sectoral TFP, $\overline{A}_s$, depends on the price elasticity of demand, σ_s.

[8] HK show that their results about the Chinese and Indian TFPGAPs are not very sensitive to the assumption of the Cobb-Douglas aggregation.

2.5 Data

The data we use for our analysis are the establishment-level data underlying the *Census of Manufactures* published by the Ministry of Economy, Trade and Industry. In years ending with 0, 3, 5, and 8, the Census covers all establishments located in Japan (excluding those belonging to the government) and falling into the manufacturing sector.[9] In other years, the Census covers establishments with four or more employees. Since we need data on fixed tangible assets to construct establishment-level TFPQ, we use only those establishments for which such data are available. The Census reports fixed tangible assets for establishments with 10 employees or more for 1981-2000 and 2005, and for those with 30 employees or more for 2001-2004 and 2006-2008.

The greatest merit of the Census is its long time horizon and the wide coverage of establishments in the manufacturing sector. On the other hand, an obvious shortcoming of the Census is that it excludes establishments in non-manufacturing industries.[10]

We use Census data for the period from 1981 to 2008. Information from the Census that we use is an establishment's labor compensation (excluding non-wage compensation), value added, and capital stock as well as what industry (at the four-digit level) it belongs to. We reclassify establishments into 51 industries based on the Japan Industrial Productivity (JIP) Database, published by the Research Institute of Economy, Trade and Industry (RIETI), to use the industry-level labor shares of the JIP Database as described below.

To measure establishment-level distortions and TFPQ, we adjust the quality of workers and hours worked based on the assumption that the quality and hours worked is reflected in the establishment-level wage relative to the industry average.

We set the rental price of capital to $R = 0.1$, based on our assumption that the interest rate is 4% and the depreciation rate is 6%. Another reason for setting the value of $R = 0.1$ is that we intend to compare our estimates for Japan with those for the United States by HK, who use the same value. We set the elasticity of substitution between products, σ_s, based on Broda and Weinstein [5] as a baseline. Specifically, we reclassify the JIP industry classifications to the Rauch [26]'s three goods categories, i.e., commodity goods, reference-priced goods, and differentiated goods (see Table 1) and set σ_s to 4.8, 3.4, and 2.5 for 1981-1989 and 3.5, 2.9, and 2.1 for 1990-2008 for each category. These values are taken from the median value of each category for 1972-1988 and 1990-2001 estimated by Broda

[9] Although the data are at the establishment level and not the firm level, most of the establishments are owned by single-establishment firms. In 2008, for example, 84.4% of the establishments (222,145 out of 263,061 establishments) were owned by single-establishment firms.

[10] Another micro-level data source frequently used in studies on producers in Japan is the *Financial Statements Statistics of Corporations by Industry (FSSC)* published by the Ministry of Finance, which does cover firms in both manufacturing and non-manufacturing industries. However, firms with equity capital of less than 600 million yen (about 7.5 million dollars) are randomly sampled in the *FSSC*, which makes it difficult to construct a panel dataset.

and Weinstein [5].[11] To compare our results with those of HK, we alternatively set $\sigma_s = 3$ for all the industries for the entire period, which is the same as the value used by HK. The TFP gap is increasing in σ, so we chose σ conservatively given that estimates of the substitutability of competing manufactures range mostly from 2 to 8.[12]

We set α_s as one minus the industry-level labor share, meaning that we assume that in each industry rents from mark-ups are divided pro rata into payments to labor and capital. Industry-level labor shares are taken from the JIP Database.

To exclude outliers, we trim the 1% tails of the marginal revenue of capital, the marginal revenue of labor, and TFPQ, all of which are standardized by the industry averages, and recalculate the industry-level variables.[13] The number of establishments per observation year varies from 39,981 to 170,789 during the period we focus on. The number of total establishment-year observations in our dataset is 3,565,341. See Appendix B for more details on how we constructed our dataset.

2.6 Aggregate TFP Losses and Establishment-size Distribution

In this subsection, we report the results from using σs based on Broda and Weinstein ([5]) unless otherwise specified. Figure 1 depicts the distribution of the measured establishment-level values of $log(A_{si})$, $log(1 - \tau_{Ysi})$, and $log(1 + \tau_{Ksi})$, while Table 2 provides the descriptive statistics of $log(A_{si})$, τ_{Ysi}, and τ_{Ksi}. The standard deviation of $log(A_{si})$ from its industry mean is 2.02.[14] The median values of τ_{Ysi} and τ_{Ksi} are -0.39 and 0.71, respectively, suggesting that a typical firm obtains "subsidies" on its output and pays "taxes" on its capital.

[11] Broda and Weinstein [5] estimate elasticities of substitution among goods using the U.S. trade data (the Tariff System of the U.S.A. (TSUSA) seven-digit for 1972-1988 Harmonized Tariff System (HTS) ten-digit for 1990-2001. Using their estimates, we implicitly assume that elasticities of substitution among goods produced in Japan are the same as those among U.S. imports.

[12] Using U. S. trade data, Broda and Weinstein [5], for example, find that the median value of the elasticity of substitution ranges from 2.2 to 3.7, depending on different aggregation levels and time periods. Meanwhile, Cooper and Ejarque [10], conducting a structural estimation of investment, found that the estimated elasticity of profits with respect to capital was around 0.7, which, together with a capital share of 1/3, implies a markup of about 15%, which is equivalent to a σ of about 8. Finally, using establishment-level data from Japan's *Census of Manufactures* for the period 1981-2000, Kwon et al. [20] estimated production functions by industry and found average returns to scale, which correspond to $\frac{\sigma-1}{\sigma}$, ranging from 0.461 to 1.038, suggesting that the lower bound of σ is 1.855.

[13] Specifically, we trim the 1% tails of $log(MRPK_{si}/\overline{MRPK}_s)$, $log(MRPL_{si}/\overline{MRPL_s})$ and $log(A_{si}/\bar{A}_s)$ and recalculate wL_s, K_s, P_sY_s, $\overline{TFPR}_s$, θ_s, $\bar{A}_s$, and $\hat{A}_s$. See Appendix A for the definitions of these variables.

[14] The estimate of the standard deviation of $log(A_{si})$ here is larger than that by HK (0.83 on average for the three observation years). When setting σ to the same value adopted by HK, 3, we find that he standard deviation of $log(A_{si})$ from its industry mean is 0.97, much closer to that by HK. HK suggest that one of the reasons for the difference between their estimates and the estimate by Foster et al. [13], which is 0.22, is that their (and hence our) TFPQ estimates should reflect the quality and variety of a establishment's product, not just the establishment's physical productivity. Another reason is that HK's results (and ours) cover all industries, whereas Foster et al. analyze only eleven industries whose products are deemed to be homogeneous.

Table 3 shows that the TFPGAP arising from both types of distortions is 0.717 on average during the observation period, suggesting that without any distortions aggregate TFP would be 39.6% higher. Setting σ to 3, we find that the TFPGAP and the TFPGAIN do not substantially change, which are 0.690 and 44.9%, respectively. With the caveat that we have not examined our results for potential measurement error or model misspecification, let us compare our result from setting σ to 3 with that for the United States obtained by HK.[15] If, hypothetically, capital and labor were reallocated in Japan to equalize marginal products to the extent observed in the United States, manufacturing TFP in Japan would increase by 6.2%. Moreover, if capital and labor were hypothetically to be reallocated in Japan to equalize marginal products to the extent observed in the worst year in the United States, manufacturing TFP in Japan would rise by 1.4%, which is much smaller than HK's estimates for China (30%-50%) and India (40%-60%). To examine whether our results for Japan's TFPGAIN are plausible or not, we need an appropriate proxy for allocation efficiency across countries. Although far from an accurate proxy, we use the country ranking provided in World Bank [29], which compares regulations for domestic firms in 183 economies and ranks them in the order of ease of doing business as of 2010.[16] Our estimate of Japan's allocation efficiency, which lies between HK's estimates for China and India on one hand and their estimates for the United States on the other, is roughly consistent with the World Bank ranking: the United States, Japan, China, and India rank in 4th, 20th, 91st, and 132nd place, respectively. As for specific factors that result in inefficient allocation, HK point out state ownership of establishments in China and licensing and size restrictions in India. In Japan, most manufacturing establishments are privately owned and not subject to licensing or size restrictions. This may explain why resource allocation in the manufacturing sector is substantially more efficient in Japan than in China or India.

Table 3 also shows that $TFPGAP_{capital}$ is 0.826 (in the case of σs based on Broda and Weinstein ([5]), suggesting that aggregate TFP would rise by 21.1% if capital distortions were removed, which accounts for about half of the TFP gain from removing distortions on both capital and labor (39.6%).

Table 4 shows the actual-to-efficient TFP by industry averaged over 1981-2008, indicating a large variation in allocation efficiency across industries ranging from the least efficient pharmaceutical products industry (0.524) to the most efficient rubber products industry (0.832).

Next, we calculate the efficient size distribution that would be realized without any distortions and compare it with the actual size distribution. Both the actual and efficient size distributions are calculated by pooling all the establishment-year ob-

[15] The comparison between Japan and the United States is not precise because we set α_s based on the JIP database, while HK set it from the NBER productivity database.

[16] The World Bank ranking is based on a number of quantitative measures of regulations for starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency.

servations. We measure establishment size in terms of value added. As discussed above, (2.11) suggests that removing distortions may or may not reduce size dispersion depending on the variance of distortions, depending on their correlation with TFPQ, and their correlation with each other. Figure 2 shows that the efficient size distribution is more dispersed than the actual one. Table 5 presents a number of key statistics on the actual size distribution (in column (1)) and the hypothetical efficient size distributions in the baseline case(in column (2)). We see that the interquartile range (i.e., the difference between the upper and lower quartiles) of the efficient size distribution is slightly larger than that of the actual one. Looking at the size distribution in detail, we find that without distortions, the largest establishments (top 0.01% to top 20%) should have a larger share, while the smallest establishments (bottom 20%) should have a smaller share. Setting σ_s to 3, we find (unreported to save space) that although the results for the size distribution do not qualitatively change, the difference between the hypothetical size distribution in this case and the actual one is much larger than in the baseline case (σ_s based on Broda and Weinstein ([5]). Our result from σ_s being 3 are similar to the result obtained by HK for the United States.

To examine the effects of only capital distortions on the size distribution, we also examine the hypothetical size distribution that would be realized if we removed output distortions while keeping capital distortions as they are. Figure 3 compares the actual distribution with this hypothetical distribution and shows that the the hypothetical distribution is more concentrated than the actual distribution. 2. This is also confirmed in Table 5, where the distribution with distortions on capital only is shown in column (3). Interestingly, without output distortions, the largest establishments (top 0.01% to top 20%) should have a larger share, while the smallest establishments (bottom 20%) should have a smaller share than the actual distribution. On the other hand, comparing the two hypothetical distributions in columns (2) and (3), we see that removing capital distortions would increase the interquartile range of output. Removing capital distortions increases the share of the largest establishments and decreases the share of the smallest establishments.

2.7 Robustness

In order to examine the robustness of our baseline calculations of the hypothetical efficiency gains and establishment-size distributions, we conduct a number of checks.

First, we calculate TFPGAP and the hypothetical size distributions for three subperiods, 1981-89, 1990-99 and 2000-08. Table 6 shows the results. TFPGAP declines over the three decades, suggesting that the efficiency of resource allocation in Japan worsened. This tendency is also evident in Figure 4, which depicts TFPGAP over time. While Japan has gradually deregulated in various fields, including financial markets, over the last three decades, the decline in GDP growth may have impeded the smooth reallocation of resources.[17] Our findings concern-

[17]Regulations on corporate bond issuance, for example, started to be gradually relaxed in the 1980s

ing the size distribution are valid for all three subperiods. That is, the efficient distributions that would be achieved without capital or output distortions are more dispersed with larger shares of the top 1% establishments and smaller shares of the bottom 20% establishments than the actual distribution.

Next, to see whether our results are sensitive to the change in the coverage of the Census over time, we redo our calculation using the data of 1981-2000 and 2005, in which all the establishments with 10 employees or more are covered. The results are reported in Column (2) of Table 7. We find that the TFPGAPs did not virtually change: $TFPGAP$ and $TFPGAP_{capital}$ are 0.722 and 0.832, respectively. Although the actual and hypothetical size distributions change from the baseline results, it still holds that the hypothetical, efficient size distributions that would be realized without capital or output distortions would be more dispersed with larger shares of the largest establishments and the smaller shares of the smallest establishments.

Thirdly, we employ an alternative approach to treating outliers. In the baseline, we drop outliers lying in the 1% tails of the marginal revenue of capital, the marginal revenue of labor, and TFPQ, all standardized by the industry averages.[18] In the alternative approach, we use a 2% cut-off for the standardized marginal revenues of labor and capital and TFPQ. Column (4) shows that the hypothetical TFP gains from removing all distortions fall from 39.6% to 31.6%, while the TFP gains from removing only capital distortions fall from 21.1% to 15.5%. Thus, the measurement error in the 2% tails may be important, but there still remain large gains from removing distortions. In addition, HK report a similar fall in their measurement of TFP gains for China and India (from 87% to 69% for China, and from 128% to 106% for India) when the 2% threshold is employed. Thus, the difference between the potential efficiency gains in Japan on the one hand and China and India on the other remain virtually the same. Moreover, comparing the hypothetical size distributions and the actual distribution yields results similar to the baseline results.[19]

Finally, we set $\sigma_s = 6$ for all the industries to examine the sensitivity of our results to the elasticity of substitution among goods within an industry. The results are reported in Column (4) of Table 6. We find that the TFP gains from removing both output and capital distortions amount to 36.7% in the case of $\sigma_s = 6$, which is slightly lower than the 39.6% in the baseline case(column (1)). The TFP gains from removing capital distortions also decrease from 21.1% to 9.5%. Most of the implications of distortions for the establishment-size distribution are similar to the baseline results. Overall, these results suggest that the effects of distortions are quantitatively somewhat sensitive to this elasticity, while they are not qualitatively so.

and were completely lifted in 1996 (Hoshi and Kashyap [16]).

[18] See footnote 13.

[19] We further analyze how our measures of distortions and TFPGAP are affected by the misspecification of production technology. Specifically, we investigate the case where land (and other natural resources) is required as an input. See Appendix C.

2.8 Entry and Exit

In this subsection, we analyze how the distortions affect establishment entry and exit using the baseline estimates of output and capital distortions. Given the elasticity of demand to price (σ_s), distortions are likely to lower profits, and thus potentially lower the share of new entrants and heighten the probability of exit. If, however, entry restrictions hinder potential entrants' entry and give incumbents high rents, then entry restrictions will manifest itself as a high output distortion and, at the same time, may lower the probability of exit. Calibrating a general equilibrium model of firm dynamics, Bartelsman et al. [3] find that misallocation distortions have a significant impact on endogenous selection, i.e., entry and exit. We examine this relationship using our establishment-level dataset. Specifically, we estimate the following Probit model:

$$
\begin{aligned}
(2.12)\; & Prob(Exit_{sit} = 1) \\
= \; & \beta_1 Adjusted\,\overline{TFPR}_{st-1} + \beta_2 \frac{TFPQ_{sit-1}}{TFP_{st-1}} \\
+ \; & \beta_3 log(1 - \tau_{Ysit-1}) + \beta_4 log(1 + \tau_{Ksit-1}) \\
+ \; & \beta_5 log(age_{sit-1}) + yeardummy_t + industrydummy_s + \epsilon_{sit},
\end{aligned}
$$

where s denotes industry, i denotes establishment, and t denotes year. The dependent variable is the exit dummy that takes one if establishment i in industry s exits in year t, and zero if it survives. The first term in the right hand side is the industry-level average of the revenue-based productivity ($TFPR_{sit}$) in year t adjusted for the difference in the elasticity of substitution among industries (σ_s).[20] The higher the industry-level averages of output and capital distortions are, the greater the industry-level average of the revenue-based productivity and the smaller number of establishments are expected to exit. Therefore, the coefficient on $TFPR_s$ is expected to be negative. The second term is the establishment TFPQ relative to its industry average. The natural selection hypothesis implies that an establishment with lower TFPQ is more likely to exit. Therefore, the coefficient on the second term is expected to be negative. The third term, which represents the logarithm of one minus the output distortion, is expected to take a negative coefficient if output distortions depress profits and promote exits. On the other hand, if entry restrictions result in output distortions and give incumbents high profits, then the third term is expected to take a positive coefficient. The fourth term, representing the logarithm of one plus the capital distortion, is expected to take a positive coefficient if, for example, establishments that face external finance constraints are more likely to exit.[21] The fifth term is the logarithm of establishment age, i.e., the number of years passed since its foundation. Existing studies (e.g., Evans [12]) find

[20] See (A.1) in Appendix A for the definition of $adjusted\,\overline{TFPR}_{st}$. The results in Tables 8 and 9 do not virtually change if we replace $adjusted\,\overline{TFPR}_{st}$ with $\overline{TFPR}_{st}$.

[21] If $log(1 - \tau_{Ysit-1})$ and $log(1 + \tau_{Ksit-1})$ are replaced with τ_{Ysit-1} and τ_{Ksit-1}, respectively, the estimation procedure was not converged.

that young firms or establishments are more likely to exit. Given such evidence, we expect the fifth term to take a negative coefficient. We add the second- to fourth-order terms of the logarithm of establishment age to take into consideration a possible nonlinear relationship between age and exit probability. Finally, $yeardummy$ and $industrydummy$ represent a year dummy, which captures macroeconomic shocks, and an industry dummy, which captures industry-specific effect, respectively.

Table 8 shows the estimation results. First, the marginal effect of the industry-level revenue-based productivity is negative and significant, showing that establishments falling into industries with higher average distortions are more likely to exit. Second, the marginal effect of the establishment-level TFPQ relative to its industry average is negative and significant, which is consistent with the natural selection hypothesis. Thirdly, the establishment-level output and capital distortions significantly heighten the exit probability, suggesting that those distortions depress profits. For example, the exit probability of an establishment whose $log(1 - \tau_Y)$ is lower by one standard error (0.706) is higher by 1.5%, while the exit probability of an establishment whose $\log(1 + \tau_K)$ is higher by one standard error (1.141) is higher by 1.5%. Finally, the logarithm of establishment age is negative and significant, as is expected, while the second- to fourth-order terms of the logarithm of establishment age are not significant.

Next, we analyze how the industry-level share of new entrants is correlated with the industry-level distortions by estimating the following industry-level panel model:

$$Entry_{st} = \beta_1 Adjusted\,\overline{TFPR}_{st} + industry_s + year_t + \epsilon_{st}, \qquad (2.13)$$

where s and t denote industry and year, respectively. The dependent variable is the share of new entrants in the total number of establishments in the industry the entrant falls into. We define new entrants as the establishments that are newly filed in the *Census*, which covers all establishments with 10 or more employees. Among the explanatory variables, $Adjusted\,\overline{TFPR}_{st}$ is the industry-level average of revenue-based productivity adjusted for the difference in the elasticity of substitution among industries, which is higher as capital and output distortions are larger. $industry_s$ and $year_t$ are industry- and year- dummies, respectively. The observation period is limited to the years for which the *Census* consecutively covers all establishments with 10 or more employees, that is, 1982-2000. [22]

Table 9 shows the estimation results. The coefficient on $\overline{TFPR}_{st}$ is negative and significant, suggesting that the higher the industry-average distortions are, the lower the share of new entrants is.

[22] We tried both random industry-effect model and fixed industry-effect model, but we could not conduct the Hausman test since the difference between the two models are too small. Omitting year dummies, we could conduct the Hausman test, which rejected the fixed effect model. Therefore, we report the estimation results of the random industry-effect GLS model, although the sign and significance of $Adjusted\,\overline{TFPR}_{st}$ are the same between the random and fixed effect models.

In sum, output and capital distortions affect the entry and exit of establishments as well as the size distribution of incumbent establishments. The higher the industry-average distortions are, the smaller the shares of entering and exiting establishments are in the industry. Furthermore, within an industry, the larger the output and capital distortions an establishment faces, the higher the probability of exit is for that establishment.

2.9 Establishment-level Productivity Growth

Thus far we have analyzed the effects of establishment-level distortions on the aggregate productivity, the size distribution, and the entry and exit behavior given the establishment-level physical productivity (TFPQ). In fact, however, distortions may affect the establishment-level physical productivity as well. Midrigan and Xu [21], for example, show that financial frictions affect firms' technology adoption and thus productivity. [23] In this subsection, we explore this possibility by estimating the following equation:

$$GTFPQ_{si} = \beta_0 + \beta_1 \frac{TFPQ_{si0}}{TFPQ_{s0}} + \beta_2 \tau_{Ysi0} + \beta_3 \tau_{Ksi0} + year_0 + industry_s + \epsilon_{it}, \tag{2.14}$$

where the subscripts s, i, and t respectively denote the indexes of industry, establishment, and year. The subscript 0 denotes the year when the establishment enters the market. The dependent variable, $GTFPQ_{si}$, is the average growth rate of establishment i falling into industry s over the years after entrance. The numerator of the first variable in the right hand side, $TFPQ_{si0}$, is the physical productivity of establishment i in the year of entry. The denominator, $TFPQ_{s0}$, is the industry-average of the physical productivity of the industry that establishment i falls into in the year of i's entry. The second and third variables represent the output and capital distortions in the year of entry. $year_0$ denotes the year dummy at the time of entry, and $industry_s$ denotes the industry dummy.

The estimation results are shown in Table 10. Column (1) shows the results for the whole observation period (1981-2008), while Column (2) indicates the results for the sub-period of 1981-2000. In the whole observation period, establishments with less than 30 employees are not included in 2001-2004 and 2006-2008, while in the sub-period of 1981-2000, such small establishments are included in all the observation years.[24] Despite such differences in the establishments and the periods covered, the two results are both qualitatively and quantitatively similar. The

[23] See also Akiyoshi and Kobayashi [1] for a theoretical analysis on the external financial constraints and firm productivity.

[24] This is because the Census reports fixed tangible assets for establishments with 10 employees or more for 1981-2000 and 2005, and for those with 30 employees or more for 2001-2004 and 2006-2008, as we explained in Section 2.5

coefficient on the first variable is negative and significant, suggesting that establishments that entered with relatively high physical productivity exhibit low TFPQ growth rates subsequent to entry. The coefficient on the second and third variables are both negative and significant, suggesting that output and capital distortions significantly lower the TFP growth rate subsequent to entry. We can interpret this result in two ways. First, high measured distortions reflect learning, research and development, establishment of customer base, and other unobservable investment, which result in subsequent high TFPQ growths. HK find a negative correlation between the establishment-level revenue productivity (TFPR) and the growth rate of physical productivity (TFPQ), interpreting this finding as suggesting that measured distortions reflect unobservable investment. The other way of interpreting our finding here is that low (or negative) measured distortions reflect low (or negative) actual distortions, such as subsidy, which result in high growth rates of TFPQ. According to this interpretation, strict regulations, which result in high distortions, are likely to hinder the TFPQ growth rate at the establishment level.

3 Sources of Distortions

In this section, we explore the sources that result in establishment-level distortions. Although measured distortions are not free from measurement errors, if measured distortions are systematically correlated with establishment- or industry-level variables, measured distortions are not just measurement errors, but capture real distortions to some extent.

First, we analyze the relationship between distortions and physical productivity (TFPQ). Figures 5 and 6 show the distribution of output and capital distortions ($log(1 - \tau_{Ysi})$ and $log(1 + \tau_{Ksi})$), respectively, for the three classes of establishments: those with their physical productivity relative to its industry average ($log(A_{si}/\overline{A}_s)$) lie in the highest 25%, the middle 50%, and the lowest 25%. Figure 5 shows that the higher the relative TFPQ is, the higher the output distortion is. On the other hand, Figure 6 shows that the higher the relative TFPQ is, the lower the capital distortion is, though the difference in capital distortions between establishments with high and low relative TFPQ is small.

Next, considering that a number of preceding studies show that financial frictions result in distortions, which, in turn, result in misallocation of resources and aggregate TFP losses (Jeong and Townsend [19], Amaral and Quintin [2], Buera et al. [6], Moll [22], and Midrigan and Xu [21], Gilchrst et al. [14], Greenwoowd et al. [15], and Pratap and Urrutia [24]), we focus on borrowing constraints as a factor of distortions. If the supply of external finance is limited due to informational or contractual frictions, then establishments that are more dependent on external finance are likely to be subject to greater distortions. We empirically examine whether this is the case.

Following Rajan and Zingales [25], we measure external finance dependence as the difference between capital expenditures and cash flow from operations divided by capital expenditures. Cash flow from operations is the sum of current profits, depreciation, increases in notes payable, and increases in reserves for possible loan losses minus the sum of increases in notes receivable, corporate taxes, and increases in inventory. We use the industry-level median of external finance dependence using a dataset of Japanese listed firms over the period of 1981-2007. The database we use is the NEEDS-Financial Quest compiled by Nikkei Digital Media, Inc. The industry classification is based on the JIP Database, which contains 51 manufacturing industries.

We use the external finance dependence ratios of publicly listed firms rather than those of our sample establishments for the following reasons. First, information on external financing by our sample establishments is not available. Second, even if such information were available, it would not be useable because it would reflect the equilibrium between the demand for external funds and its supply. This is problematic since we need a measure of the demand for external finance to test whether a establishment that demands a large amount of external funds faces large distortions. Publicly listed firms, on the other hand, are less likely to be constrained by the supply of external funds and consequently their external finance dependence ratios are more likely to reflect only the demand for external finance than small and unlisted firms, which constitute most of our sample firms. Finally, financial statements of publicly listed firms are less susceptible to measurement errors than those of unlisted firms. The external finance dependence ratio for each industry is assumed to depend on industry-specific technological factors, including the initial project scale, the gestation period, the cash harvest period, and the requirement for continuing investment.[25]

A complicating factor in calculating the external finance dependence ratio is that it is difficult to find a period in which supply factors did not play a role: while financial market deregulation was more or less completed in the mid-1990s (see, e.g., Hoshi and Kashyap [16]), this was immediately followed by the banking crisis in Japan (1995-2005). We therefore chose to take the long-run average of external finance dependence to lessen the supply factors arising from the regulations and the banking crisis. We excluded the year 2008, when the global financial crisis affected Japanese financial markets. Table 11 shows the external dependence ratios across industries in descending order.

We conduct the following establishment-level regression using weighted least squares with industry value-added shares as weights:

$$Distortion_{sit} = \beta Fin_s + \gamma X_{sit} + \alpha Year_t + \epsilon_{sit}. \tag{3.1}$$

The dependent variable, $Distortion_{sit}$, is either $TFPRGAP_{sit} \equiv \frac{(1+\tau_{Ksit})^{\alpha_s}}{1-\tau_{Ysit}}$, τ_{Ysit}, or τ_{Ksit}, where $TFPRGAP_{sit}$ is the ratio of the actual TFPR to the efficient TFPR (see (2.10)).

[25] Rajan and Zingales [25] use the industry-level median of US publicly listed firms to examine whether industrial sectors that are relatively more in need of external finance develop disproportionately faster in countries with more developed financial markets.

The explanatory variables are Fin_s, our measure of external finance dependence, X_{sit}, a vector of establishment- and industry-specific control variables described below, and $Year_t$, a year dummy. ϵ_{sit} is the disturbance term.

As control variables X_{sit}, we include an establishment size, which is measured as the log of the number of employees; organization dummies representing whether a firm is a sole proprietorship, a corporation, or a cooperative (the latter is used as the reference category); an industry-level index of government regulation; a set of variables to gauge the age structure of workers in an industry, consisting of the share of workers in each 10-year age brackets (e.g., 20-29 year olds, 30-39 year olds, etc., with the under 20 age bracket used as the reference group); and the average share of part-timers in an industry. The establishment-level variables are taken from the Census, while the industry-level variables are taken from the JIP Database.

The expected signs for these variables are as follows. The regulation index is expected to take a positive coefficient in all regressions. Next, establishment size may take either sign in the regressions for τ_{Ksit} and $TFPRGAP_{sit}$. If subsidies to SMEs, especially subsidized credit from state-owned financial institutions, reduce the external financing costs of smaller firms, then establishment size will take a negative coefficient. On the other hand, if small firms are more opaque and more likely to be financially constrained, then establishment size will take a positive coefficient. Turning to the organization dummies, since proprietorships tend to be smaller than cooperatives, the sole proprietorship dummy is expected to take the opposite sign to that on establishment size. On the other hand, the corporation dummy is expected to take the same sign as establishment size. As for the labor-related variables, we expect that regular workers and older workers are more secure in their jobs and receive higher wages relative to their productivity than part-timers and younger workers. If this is the case, the coefficient on the share of part-timers will take a negative coefficient, while the shares of workers in higher age brackets will take positive coefficients in the regression for τ_{Ysit} and possibly in the regression for $TFPRGAP_{sit}$.[26] On the other hand, firms may be willing to pay high wages to part-timers relative to their labor productivity because they are more easy to hire than full-time workers. In this case, the share of part-timers will take a positive coefficient in the regression for τ_{Ysit} and possibly in the regression for $TFPRGAP_{sit}$.

The number of observations for which data is available is 3,424,558. From these observations, we drop those for which the dependent variables fall in the top and bottom 2% in each distribution, leaving us with the number of observations ranging from 3,324,795 to 3,336,281 depending on the dependent variables. The estimation results are shown in Table 12, where standard errors are adjusted for clustering at the industry level. The first to third columns show the regres-

[26]Under a seniority-based wage system, firms may pay high wages to older workers relative to their productivity in order to give young workers incentives to acquire firm-specific skills. Such a wage system may enhance long-run firm-level productivity even when it leads to static distortions.

sion results for $TFPRGAP_{sit}$, τ_{Ysit}, and τ_{Ksit}, respectively. As for the external finance dependence variable, its coefficients are positive and significant in the regressions for all the distortion variables, although the significance level for τ_{Ksit} is marginal.[27] The regression in column (4) again uses τ_{Ksit} as the dependent variable, but also includes the log of firm age. The reason for including firm age is that theoretical and empirical studies suggest that young firms are more likely to be financially constrained (see, e.g., Diamond [11] and Sakai et al. [28]). The result in column (4) is consistent with those preceding studies; that is, Log(age) in column (4) is significant and negative.

The coefficient on TFPQ is positive and significant in the regressions for $TFPRGAP_{sit}$ and τ_{Ysit}, the latter of which is consistent with Figure 5, while it is negative and significant in the regressions for τ_{Ksit}.

Among the control variables, the regulation index is not significant. Size (log of the number of employees) takes negative and significant coefficients for all the distortion variables. We should be careful to note, however, that establishment size potentially is an endogenous variable that is affected by the degree of distortions. The dummy for sole proprietorships takes negative and significant coefficients in the regressions for $TFPRGAP_{sit}$ and τ_{Ysit}, while it takes positive and significant coefficients in the regressions for τ_{Ksit}. The latter result is consistent with the view that sole proprietorship is more difficult to obtain external finance than corporations, although the corporation dummy takes no significant coefficient. All the variables representing the share of workers in each of the age groups (with under 20s as the reference group) takes positive and significant coefficients in the regressions for $TFPRGAP_{sit}$ and τ_{Ysit}, suggesting that firms pay high wages to over-20s workers relative to their productivity. This result suggests that a seniority-based wage system is prevelent among Japanese firms.[28] In the regressions for τ_{Ksit}, only the share of workers aged 50s is negative and marginally significant. Finally, the share of part-timers does not take a significant coefficient in any regressions.

We further add to the explanatory variables an export dummy that takes one if the establishment exports. Due to data availability, the observation period is limited from 2001 to 2008. Exporters may potentially face higher costs associated with exports or various taxes and transportation costs. If this is the case, the coefficient on the export dummy will be positive in the regression for τ_{Ysit} and possibly in the regression for $TFPRGAP_{sit}$. Table 13 shows that the export dummy takes a positive and significant coefficient in the regression for $TFPRGAP_{sit}$ and τ_{Ysit}, as expected, while it takes a negative and significant coefficient in the regressions for or τ_{Ksit}. The other variables have coefficients similar to those in Table 12 except for the external finance dependence, which is now positive and (marginally)

[27] Table 11 shows that the external finance dependence measure is negative for the seafood products (9) and publishing (92) industries. To test whether this affects our results, we drop the establishments in these two industries, and obtain similar results for $TFPRGAP_{sit}$ and τ_{Ysit}, but obtain an insignificant coefficient on τ_{Ksit}.

[28] See footnote 26.

significant only in the regression of $TFPRGAP_{sit}$. The weak impact of external finance dependence on distortions in Table 13 may be due to the difference in the observation period; in the 2000s, the Japanese financial system was more stable than it had bee in the 1990s.

In sum, most of the control variables take coefficients with the expected sign, suggesting that our measure of distortions indeed appears to capture real distortions rather than just measurement errors.

4 Conclusion

The purpose of this paper is to offer new evidences on the effects of establishment-level distortions on aggregate TFP, establishment-size distribution, entry/exit behaviors, and establishment-level TFP growth rate using a rich dataset of Japanese establishments falling into manufacturing industries. We further aim at revealing the sources that result in establishment-level distortions.

Our main findings are the followings. First,if capital and labor were reallocated in Japan to equalize marginal products to the extent observed in the United States, aggregate TFP would increase by 6.2%. Second, the efficient size distribution of establishments that would be realized without any distortions would be more dispersed than the actual one. Third, industry-level distortions have significant negative impacts on entry and exit in the industry, while establishment-level distortions have a significant positive impact on the probability of the establishment's exit. Fourth, establishment-level distortions have a significant negative impact on the establishment's productivity growth subsequent to entry. Finally, financial constraints result in overall distortions.

To interpret our results, we should note that this paper has focused on the static efficiency of resource allocation ignoring its dynamic effects. On one hand, measured distortions may reflect unobserved investment such as research and development and development of human resources. In this case, long-run effects of distortions on aggregate output may be less severe or even positive even when static allocation of resources is inefficient. On the other hand, if distortions have negative impacts on capital accumulation, aggregate output losses arising from distortions may be larger than their static impacts.

To fully incorporate such dynamic impacts of distortions, we need to build a structural model that incorporates sources for distortions and to estimate the impact of policies that remove such sources for distortions. We leave this for future work.[29]

[29] See Hosono and Takizawa [17] for the model-based quantitative study concerning the effects of borrowing constraints on misallocation and resultant TFP losses. They use the same dataset used in the present paper.

Appendix

A Derivation of TFPGAP

In this Appendix, we explain how we derive aggregate TFPGAP from the producer-level distortions τ_{Ksi}, τ_{Ysi} and TFPQ, A_{si}.

First, we derive the equilibrium allocation of capital and labor across industries. Let us define a producer's marginal revenue products of capital and labor as $MRPL_{si} \equiv \frac{\partial(P_{si}Y_{si})}{\partial L_{si}}$ and $MRPL_{si} \equiv \frac{\partial(P_{si}Y_{si})}{\partial L_{si}}$, respectively. Then, from the first-order conditions, it follows that

$$MRPK_{si} = \left(\frac{\sigma-1}{\sigma}\right)\alpha_s \frac{P_{si}Y_{si}}{K_{si}} = \frac{(1+\tau_{Ksi})R}{1-\tau_{Ysi}},$$

and

$$MRPL_{si} = \left(\frac{\sigma-1}{\sigma}\right)(1-\alpha_s)\frac{P_{si}Y_{si}}{L_{si}} = \frac{w}{(1-\tau_{Ysi})}.$$

Next, we define the industry averages of MRPK and MRPL as

$$\overline{MRPK_s} \equiv \frac{R}{\sum_{i=1}^{M_s} \frac{(1-\tau_{Ysi})}{1+\tau_{Ksi}} \frac{P_{si}Y_{si}}{P_sY_s}},$$

and

$$\overline{MRPL_s} \equiv \frac{w}{\sum_{i=1}^{M_s}(1-\tau_{Ysi})\frac{P_{si}Y_{si}}{P_sY_s}}.$$

Using $P_sY_s = \theta_s PY$ and the above equations, we obtain the equilibrium allocation of capital and labor across industries:

$$K_s = \sum_{i=1}^{M_s} K_{si} = K\frac{\alpha_s\theta_s/\overline{MRPK_s}}{\sum_{s'=1}^{S}\alpha_{s'}\theta_{s'}/\overline{MRPK_{s'}}},$$

and

$$L_s = \sum_{i=1}^{M_s} L_{si} = L\frac{(1-\alpha_s)\theta_s/\overline{MRPL_s}}{\sum_{s'=1}^{S}(1-\alpha_{s'})\theta_{s'}/\overline{MRPL_{s'}}}.$$

Now let us proceed to derive industry-level TFP. As mentioned in the main text, we define the producer-level TFPR as $TFPR_{si} \equiv P_{si}A_{si} = \frac{P_{si}Y_{si}}{K_{si}^{\alpha_s}L_{si}^{1-\alpha_s}}$. Thus, from $MRPK_{si}$ and $MRPL_{si}$ above, we obtain

$$TFPR_{si} = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{MRPK_{si}}{\alpha_s}\right)^{\alpha_s}\left(\frac{MRPL_{si}}{1-\alpha_s}\right)^{1-\alpha_s},$$

which leads to (2.10) in the main text. We define the industry-level TFPR as

$$\text{(A.1)} \qquad \overline{TFPR_s} \equiv \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\overline{MRPK_s}}{\alpha_s}\right)^{\alpha_s}\left(\frac{\overline{MRPL_s}}{1-\alpha_s}\right)^{1-\alpha_s}.$$

We also define the adjusted industry-level TFPR as

(A.2)

$$Adjusted\,\overline{TFPR_s} \equiv \frac{\sigma_s - 1}{\sigma_s}\alpha_s^{\alpha_s}(1-\alpha_s)^{(1-\alpha_s)}\overline{TFPR_s} = \overline{MRPK_s}^{\alpha_s}\overline{MRPL_s}^{1-\alpha_s}.$$

Defining the industry-level TFP as $TFP_s \equiv \frac{Y_s}{K_s^{\alpha_s}L_s^{1-\alpha_s}}$ and substituting L_s, K_s, and $TFPR_{si}$ into this definition, we obtain the industry-level TFP:

$$\text{(A.3)} \qquad TFP_s = \left[\sum_{i=1}^{Ms}\left(A_{si}\frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}.$$

This shows that allocation is inefficient to the extent that τ_{Ysi} and τ_{Ksi}, and hence $TFPR_{si}$, are different across producers.

Finally, we can aggregate sectoral outputs as follows:

$$\text{(A.4)} \qquad Y = \prod_{s=1}^{S}\left(TFP_s K_s^{\alpha_s}L_s^{1-\alpha_s}\right)^{\theta_s}.$$

If $\tau_{Ksi} = \tau_{Ysi} = 0$ for all i , then $TFPR_{si} = TFPR_s$ for all i and TFP_s would be at its efficient level, $\overline{A}_s \equiv \left(\sum_{i=1}^{Ms} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$. Given K_s and L_s, aggregate output would be at its efficient level, $Y_{efficient} \equiv \prod_{s=1}^{S}\left(\overline{A}_s K_s^{\alpha_s}L_s^{1-\alpha_s}\right)^{\theta_s}$.

We define TFPGAP as the ratio of the actual aggregate output to the efficient aggregate output that would be achieved without distortions while keeping industry-level capital and labor at actual levels:

$$TFPGAP \equiv \frac{Y}{Y_{efficient}} = \prod_{s=1}^{S}\left(\frac{TFP_s}{\overline{A}_s}\right)^{\theta_s} = \prod_{s=1}^{S}\left[\sum_{i}^{Ms}\left(\frac{A_{si}}{\overline{A}_s}\frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{\theta_s}{\sigma-1}}$$

We also report TFPGAIN that measures the gains of TFP from removing all distortions:

$$TFPGAIN \equiv \frac{1}{TFPGAP} - 1$$

To isolate the effect of capital distortions, we derive $TFPGAP_{capital}$, that is, the ratio of the actual aggregate TFP to the aggregate TFP that would be achieved without output distortions only. Let $\hat{A}_s$ denote the sectoral productivity achieved if $\tau_{Ysi} = 0$ for all i, but τ_{Ksi} remains at the actual level. A bit of algebra yields

$$\hat{A}_s = \frac{\left[\sum_{si=1}^{Ms} \left(\frac{A_{si}}{(1+\tau_{Ksi})^{\alpha_s}}\right)^{\sigma-1}\right]^{\alpha_s + \frac{1}{\sigma-1}}}{\left[\sum_{si=1}^{Ms} \left(\frac{1}{1+\tau_{Ksi}}\right)\left(\frac{A_{si}}{(1+\tau_{Ksi})^{\alpha_s}}\right)^{\sigma-1}\right]^{\alpha_s}}$$

Then, we can define $TFPGAP_{capital}$ as the ratio of actual aggregate output to the aggregate output that would be achieved without output distortions while keeping the sectoral capital and labor at their actual levels:

$$TFPGAP_{capital} = \prod_{s=1}^{S} \left(\frac{TFP_s}{\hat{A}_s}\right)^{\theta_s} = \prod_{s=1}^{S} \left[\sum_{i}^{Ms} \left(\frac{A_{si}}{\hat{A}_s} \frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{\theta_s}{\sigma-1}}$$

B Measurement of Establishment-Level Output and Input

This appendix describes how we measure establishment-level output and input. We construct output and input data as follows.

Gross Output is measured as the sum of shipments, revenues from repairing and fixing services, and revenues from performing subcontracted work. Gross output is deflated by the output deflator taken from the Japan Industrial Productivity (JIP) Database 2010 and converted to values in constant prices of 2000.

Intermediate Input is defined as the sum of raw materials, fuel, electricity and subcontracting expenses for consigned production used by the establishment. Using the corporate goods price index (CGPI) published by the Bank of Japan, intermediate input is converted to values in constant prices of 2000.

Value Added ($P_{si}Y_{si}$) is defined as the difference between gross output and intermediate input.

Capital Input (K_{si}) is measured as real capital stock, defined as follows:

Capital Input (K_{si}) = Nominal book value of tangible fixed assets from the *Census of Manufactures* x Book-to-market value ratio for each industry (γ_{st}).

The book-to-market value ratio for each industry (γ_{st}) is calculated using the industry-level data of real capital stock (K_{st}^{JIP}) and real value added (Y_{st}^{JIP}) taken from the JIP Database as follows:

$$\frac{Y_{st}^{JIP}}{K_{st}^{JIP}} = \frac{\sum_{i \in s} Y_{sit}^{CM}}{\sum_{i \in s} BVK_{sit}^{CM} \times \gamma_{st}}.$$

$\sum_{i \in s} Y_{sit}^{CM}$ is the sum of establishments' value added and $\sum_{i \in s} BVK_{sit}^{CM}$ is the sum of the nominal book value of tangible fixed assets of industry s in the *Census of Manufactures*.

Labor Input. We first explain how we adjust hours worked (and efficiency units) per worker. Let $\tilde{w}_{si}$ denote the wage rate per worker, and w_s the wage rate per hour. Denoting hours worked by h_{si}, we have $\tilde{w}_{si} = w_{si}h_{si}$. Similarly, denoting the number of workers by $\tilde{L}_{si}$ and total hours worked by L_{si}, we obtain $\tilde{L}_{si} = \frac{L_{si}}{h_{si}}$. We can observe only $\tilde{w}_{si}$ and $\tilde{L}_{si}$ but need w_{si} and L_{si}. We assume that w_{si} is identical across establishments within an industry and thus is given by w_s . Then, standardizing hours worked (and efficiency units) by $\sum_{si=1}^{Ms} L_{si} = \sum_{si=1}^{Ms} \tilde{L}_{si}$, we obtain

$$w_s = \frac{\sum_i \tilde{w}_{si}\tilde{L}_{si}}{\sum_i \tilde{L}_{si}},$$

and

$$L_{si} = \frac{\tilde{w}_{si}\tilde{L}_{si}}{w_s}.$$

Note that all the right hand side variables are observable. In our analysis, for $\tilde{w}_{si}$, we use establishment-level wage compensation divided by the number of workers $\tilde{L}_{si}$, multiplied by the non-wage compensation ratio. The non-wage compensation ratio is aggregate non-wage compensation divided by aggregate wage compensation obtained from the System of National Accounts (SNA) of Japan.

C Measurement Errors due to Omitting Inputs

In order to examine the potential measurement errors arising from omitting other inputs, in this appendix we investigate how our measure of distortions and associated TFP losses would be affected if we considered an additional production input, which we call land, although it could also include other natural resources or intangible assets. A differentiated-good producer si produces a differentiated good Ysi from capital K_{si}, land H_{si}, and labor L_{si} using a constant-returns-to-scale Cobb-Douglas production technology with idiosyncratic TFP, $\tilde{A}_{si}$,

$$Y_{si} = \tilde{A}_{si} K_{si}^{\tilde{\alpha}_s} H_{si}^{\tilde{\beta}_s} L_{si}^{1-\tilde{\alpha}_s-\tilde{\beta}_s}.$$

We consider three kinds of distortions: $\tilde{\tau}_{Ysi}$, $\tilde{\tau}_{Ksi}$, and $\tilde{\tau}_{Hsi}$, where the last one is distortions on land. The demand function is represented by (2.4), which, together with the first order conditions, implies that

$$1 + \tilde{\tau}_{Ksi} = \frac{\tilde{\alpha}_s}{1 - \tilde{\alpha}_s - \tilde{\beta}_s} \frac{wL_{si}}{RK_{si}},$$

$$1 + \tilde{\tau}_{Hsi} = \frac{\tilde{\beta}_s}{1 - \tilde{\alpha}_s - \tilde{\beta}_s} \frac{wL_{si}}{uH_{si}},$$

$$1 - \tilde{\tau}_{Ysi} = \frac{\sigma}{\sigma - 1} \frac{wL_{si}}{(1 - \tilde{\alpha}_s - \tilde{\beta}_s) P_{si} Y_{si}},$$

and

$$\tilde{A}_{si} = \kappa_s \frac{(P_{si} Y_{si})^{\frac{\sigma}{\sigma-1}}}{K_{si}^{\tilde{\alpha}_s} H_{si}^{\tilde{\beta}_s} L_{si}^{1-\tilde{\alpha}_s - \tilde{\beta}_s}}, \quad where\ \kappa_s = (P_s^{\sigma} Y_s)^{\frac{-1}{\sigma-1}}.$$

A firm's revenue productivity is

$$\widehat{TFPR}_{si} = \frac{\sigma}{\sigma - 1} \left(\frac{R}{\tilde{\alpha}_s}\right)^{\tilde{\alpha}_s} \left(\frac{u}{\tilde{\beta}_s}\right)^{\tilde{\beta}_s} \left(\frac{w}{1 - \tilde{\alpha}_s - \tilde{\beta}_s}\right)^{1-\tilde{\alpha}_s-\tilde{\beta}_s} \frac{(1+\tilde{\tau}_{Ksi})^{\tilde{\alpha}_s}(1+\tilde{\tau}_{Hsi})^{\tilde{\beta}_s}}{1 - \tilde{\tau}_{Ysi}}.$$

We define sectoral TFPR and TFP as follows:

$$\widehat{TFPR}_s \equiv \frac{\sigma}{\sigma - 1} \left(\frac{R}{\tilde{\alpha}_s \sum_{i=1}^{M_s} \frac{(1-\tilde{\tau}_{Ysi})}{1+\tilde{\tau}_{Ksi}} \frac{P_{si}Y_{si}}{P_s Y_s}}\right)^{\tilde{\alpha}_s} \left(\frac{u}{\tilde{\beta}_s \sum_{i=1}^{M_s} \frac{(1-\tilde{\tau}_{Ysi})}{1+\tilde{\tau}_{Hsi}} \frac{P_{si}Y_{si}}{P_s Y_s}}\right)^{\tilde{\beta}_s} \left(\frac{w}{(1 - \tilde{\alpha}_s - \tilde{\beta}_s) \sum_{i=1}^{M_s} (1 - \tilde{\tau}_{Ysi}) \frac{P_{si}Y_{si}}{P_s Y_s}}\right)^{1-\tilde{\alpha}_s-\tilde{\beta}_s},$$

and

$$\widehat{TFP}_s \equiv \frac{Y_s}{K_s^{\tilde{\alpha}_s} H_s^{\tilde{\beta}_s} L_s^{1-\tilde{\alpha}_s-\tilde{\beta}_s}}.$$

Then, it is straightforward to show that

$$\widehat{TFP}_s = \left[\sum_i \left(\tilde{A}_{si} \frac{\widehat{TFPR}_s}{\widehat{TFPR}_{si}}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}$$

Since we can use the sectoral labor compensation share to measure $1 - \alpha_s$ and $1 - \tilde{\alpha}_s - \tilde{\beta}_s$, we assume that these two measures are equal. Then, we obtain

$$1 + \tau_{Ksi} = \frac{\alpha_s}{\tilde{\alpha}_s}(1 + \tilde{\tau}_{Ksi}),$$

$$1 + \tau_{Ysi} = 1 + \tilde{\tau}_{Ysi},$$

and

$$A_{si} = \left(\frac{R\tilde{\beta}_s}{u\tilde{\alpha}_s} \frac{1+\tilde{\tau}_{Ksi}}{1+\tilde{\tau}_{Hsi}}\right)^{\tilde{\beta}_s} \tilde{A}_{si}.$$

To the extent that $\tilde{\alpha}_s$ is smaller than α_s, τ_{Ksi} is overestimated. On the other hand, τ_{Ysi} is measured correctly.

Next, we define the efficient sectoral TFP by $\widehat{A}_s^* = \left(\sum_i^{Ms} \tilde{A}_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$. Thus, we obtain

$$\frac{TFP_s}{\overline{A}_s} = \frac{\left(\sum_{i=1}^{M_s} \frac{(1-\tau_{Ysi})}{1+\tilde{\tau}_{Hsi}} \frac{P_{si}Y_{si}}{P_s Y_s}\right)^{\tilde{\beta}_s} \left(\sum_i^{Ms} \left(\left(\frac{1+\tilde{\tau}_{Ksi}}{1+\tilde{\tau}_{Hsi}}\right)^{-\tilde{\beta}_s} A_{si}\right)^{\sigma-1}\right)^{\frac{1}{\sigma-1}}}{\left(\sum_{i=1}^{M_s} \frac{(1-\tau_{Ysi})}{1+\tilde{\tau}_{Ksi}} \frac{P_{si}Y_{si}}{P_s Y_s}\right)^{\tilde{\beta}_s} \left(\sum_i^{Ms} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}} \frac{\widehat{TFP}_s}{\widehat{A}_s^*}.$$

Suppose that $\tilde{\tau}_{Ksi} = \tilde{\tau}_{Hsi}$ for all si. Then, we obtain that TFPGAP is measured correctly, since

$$\frac{TFP_s}{\overline{A}_s} = \frac{\widehat{TFP}_s}{\widehat{A}_s^*}.$$

References

[1] F. Akiyoshi and K. Kobayashi. Banking Crisis and Productivity of Borrowing Firms: Evidence from Japan. *Japan and the World Economy*, 22: 141-150, 2010.

[2] P. S. Amaral and E. Quintin. Limited Enforcement, Financial Intermediation and Economic Development: A Quantitative Assessment. *International Economic Review*, 51: 785-811, 2010.

[3] E.J. Bartelsman, J.C. Haltiwanger, and S. Scarpetta. Cross-country Differences in Productivity: The Role of Allocation and Selection. *American Economic Review*, 103(1): 305-334, 2013.

[4] M.N. Baily, C. Hulten, D. Campbell, T. Bresnahan, and R.E. Caves. Productivity Dynamics in Manufacturig Plants. *Brookings Papers on Economic Activity: Microeconomics*, 187-267, 1992

[5] C. Broda and D.E. Weinstein. Globalization and the Gains from Variety. *Quarterly Journal of Economics*, 121: 541–585, 2006.

[6] F. Buera, J. P. Kaboski and Y. Shin. Finance and Development: A Tale of Two Sectors. *American Economic Review*, 101(5): 1964-2002, 2011.

[7] R. J. Caballero, T. Hoshi, and A. K. Kashyap. Zombie Lending and Depressed Restructuring in Japan. *American Economic Review*, 98 (5): 1943-1977, 2008.

[8] V. V. Chari, P. J. Kehoe, and E. C. McGrattan. Business Cycle Accounting. *Econometrica*, 75: 781-836, 2007.

[9] T. F. Cooley and V. Quadrini. Financial Markets and Firm Dynamics. American Economic Review, 91: 1286-1310, 2001.

[10] R. Cooper and J. Ejarque. Financial Frictions and Investment: Requiem in Q. Review of Economic Dynamics, 6: 710-728, 2003.

[11] D. W. Diamond. Reputation Acquisition in Debt Markets. *Journal of Political Economy*, 97: 828-862, 1989.

[12] D. S. Evans. Tests of Alternative Theories of Firm Growth. *Journal of Political Economy*, 95(4): 657-674, 1987.

[13] L. Foster, J. Haltiwanger, and C. Syverson. Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *American Economic Review*, 98(1): 395-425, 2008.

[14] S. Gilchrist, J. W. Sim, and E. Zakarjšek. Misallocation and Financial Frictions. *NBER Working Paper*, 18550, 2012.

[15] J. Greenwood, H. M. Sanchez, and C. Wang. Quantifying the Impact of Financial Development on Economic Development. *Review of Economic Dynamics*, forthcoming.

[16] T. Hoshi and A. Kashyap. *Corporate Financing and Governance in Japan: The Road to the Future*, MIT Press, 2004.

[17] K. Hosono and M. Takizawa. Do Financial Frictions Matter as a Source of Misallocation? Evidence from Japan. *PRI Discussion Paper, Ministry of Finance, Japan*, 12A-17, 2012.

[18] C. Hsieh and P.J. Klenow. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(2): 1403–1448, 2009.

[19] H. Jeong and R. M. Townsend. Sources of TFP Growth: Occupational Choice and Financial Deepening. *Economic Theory*, 32: 179-221, 2007.

[20] H. U. Kwon, F. Narita, and M. Narita. Resource Reallocation and Zombie Lending in Japan in the 90s. *RIETI Discussion Paper* 09-E-052, 2009.

[21] V. Midrigan and D.Y. Xu. Finance and Misallocation: Evidence from Establishment-Level Data. `http://virgiliu.weebly.com/uploads/1/3/9/8/13982648/resubmit\_aer\_v14\_submit.pdf`, October, 2012.

[22] B. Moll. Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation? `http://www.princeton.edu/~moll/TFPFF.pdf`, October, 2010.

[23] J. Peek and E. S. Rosengren. Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan. *American Economic Review*, 95(4): 1144-1166, 2005.

[24] S. Pratap and C. Urrutia. Financial Frictions and Total Factor Productivity: Accounting for the Real Effects of Financial Crises. *Review of Economic Dynamics*, 15(3): 336-358, 2012.

[25] R. G. Rajan and L. Zingales. Financial Dependence and Growth. *American Economic Review*, 88(3): 559-586, 1998.

[26] J. Rauch. Networks versus Markets in International Trade. *Journal of International Economics*, 58: 7-35, 1999.

[27] D. Restuccia and R. Rogerson. Policy Distortions and Aggregate Productivity with Heterogeneous Establishments. *Review of Economic Dynamics*, 11: 702-720, 2008.

[28] K. Sakai, I. Uesugi, and T. Watanabe. Firm Age and the Evolution of Borrowing Costs: Evidence from Japanese Small Firms. *Journal of Banking and Finance*, 34(8): 1970-1981, 2010.

[29] World Bank. *Doing Business in a More Transparent World: Comparing Regulation for Domestic Firms in 183 Economies*. http://www.doingbusiness.org/~/media/FPDKM/Doing%20Business/Documents/Annual-Reports/English/DB12-FullReport.pdf, 2012.

Table 1: JIP Industry Classification and Rauch's Goods Classification

JIP Code	JIP Industry	Rauch's Classification
8	Livestock products	R
9	Seafood products	D
10	Flour and grain mill products	C
11	Miscellaneous foods and related products	D
12	Prepared animal foods and organic fertilizers	C
13	Beverages	D
14	Tobacco	R
15	Textile products	D
16	Lumber and wood products	R
17	Furniture and fixtures	D
18	Pulp, paper, and coated and glazed paper	D
19	Paper products	D
20	Printing, plate making for printing and bookbinding	D
21	Leather and leather products	D
22	Rubber products	C
23	Chemical fertilizers	C
24	Basic inorganic chemicals	D
25	Basic organic chemicals	D
26	Organic chemicals	D
27	Chemical fibers	D
28	Miscellaneous chemical products	D
29	Pharmaceutical products	D
30	Petroleum products	C
31	Coal products	C
32	Glass and its products	D
33	Cement and its products	C
34	Pottery	D
35	Miscellaneous ceramic, stone and clay products	D
36	Pig iron and crude steel	C
37	Miscellaneous iron and steel	D
38	Smelting and refining of non-ferrous metals	R
39	Non-ferrous metal products	D
40	Fabricated constructional and architectural metal products	D
41	Miscellaneous fabricated metal products	D
42	General industry machinery	D
43	Special industry machinery	D
44	Miscellaneous machinery	D
45	Office and service industry machines	D
46	Electrical generating, transmission, distribution	D

Table 1: JIP Industry Classification and Rauch's Goods Classification

JIP Code	JIP Industry	Rauch's Classification
	and industrial apparatus	
47	Household electric appliances	D
48	Electronic data processing machines, digital and analog computer equipment and accessories	D
49	Communication equipment	D
50	Electronic equipment and electric measuring instruments	D
51	Semiconductor devices and integrated circuits	D
52	Electronic parts	D
53	Miscellaneous electrical machinery equipment	D
54	Motor vehicles	D
55	Motor vehicle parts and accessories	D
56	Other transportation equipment	D
57	Precision machinery and equipment	D
58	Plastic products	D
59	Miscellaneous manufacturing industries	D
92	Publishing	D

Note. C, R, and D denote, respectively, commodity, reference-priced goods, and differentiated goods.

Table 2: Descriptive Statistics for log(TFPQ), Output Distortion, and Capital Distortion

	$log(A_{si})$	τ_{Ysi}	τ_{Ksi}
Mean	12.57	-0.91	3.28
Median	12.60	-0.39	0.71
Min.	2.54	-222.86	-0.99
Max.	23.67	0.97	7367.52
Std. dev.	2.18	2.11	13.56
Skewness	-0.06	-9.93	127.39
Kurtosis	2.99	333.94	48149.91
Obs.	3542793	3542793	3542793

	$log(A_{si}) - log(TFPQs)$
Std. dev.	2.02
Interquartile Range	2.72
90th percentile - 10th percentile	5.29

Table 3: TFPGAP and TFPGAIN

Elasticity of substitution	Japan Baseline	$\sigma = 3$	United States
Output distortions and capital distortions=0			
$TFPGAP$	0.717	0.690	0.733
$TFPGAIN$	39.6%	44.9%	36.60%
Output distortions=0			
$TFPGAP_{capital}$	0.826	0.821	N.A.
$TFPGAIN_{capital}$	21.1%	21.7%	N.A.

Note: The U.S. TFPGAP is the average of the values for 1977, 1987, and 1997 calculated by Hsieh and Klenow [18]. TFPGAIN is the inverse of TFPGAP minus one.

Table 4: The Actual-to-efficient TFP Ratio by Industry

	JIP industry classification	Actual-to-efficient TFP ratio
29	Pharmaceutical products	0.524
30	Petroleum products	0.564
13	Beverages	0.572
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.581
31	Coal products	0.592
49	Communication equipment	0.604
28	Miscellaneous chemical products	0.608
47	Household electric appliances	0.614
51	Semiconductor devices and integrated circuits	0.617
38	Smelting and refining of non-ferrous metals	0.618
10	Flour and grain mill products	0.633
37	Miscellaneous iron and steel	0.648
45	Office and service industry machines	0.655
23	Chemical fertilizers	0.688
12	Prepared animal foods and organic fertilizers	0.690
53	Miscellaneous electrical machinery equipment	0.690
8	Livestock products	0.692
59	Miscellaneous manufacturing industries	0.696
39	Non-ferrous metal products	0.700
92	Publishing	0.702
52	Electronic parts	0.703
32	Glass and its products	0.704
58	Plastic products	0.717
26	Organic chemicals	0.719
24	Basic inorganic chemicals	0.721
36	Pig iron and crude steel	0.723
56	Other transportation equipment	0.727
15	Textile products	0.727
57	Precision machinery and equipment	0.733
50	Electronic equipment and electric measuring instruments	0.734
27	Chemical fibers	0.736
11	Miscellaneous foods and related products	0.737
40	Fabricated constructional and architectural metal products	0.737
42	General industry machinery	0.740
35	Miscellaneous ceramic, stone and clay products	0.742
9	Seafood products	0.743
21	Leather and leather products	0.744
46	Electrical generating, transmission, distribution and	

	industrial apparatus	0.744
18	Pulp, paper, and coated and glazed paper	0.746
55	Motor vehicle parts and accessories	0.756
54	Motor vehicles	0.758
16	Lumber and wood products	0.758
43	Special industry machinery	0.758
33	Cement and its products	0.759
19	Paper products	0.768
17	Furniture and fixtures	0.775
34	Pottery	0.776
14	Tobacco	0.777
44	Miscellaneous machinery	0.786
41	Miscellaneous fabricated metal products	0.787
20	Printing, plate making for printing and bookbinding	0.799
25	Basic organic chemicals	0.800
22	Rubber products	0.832

Note. The actual-to-efficient TFP ratio by industry ($TFP_s/\overline{A}_s$) is the average over 1981-2008.

Table 5: Size Distribution

	(1) Actual output	(2) $\tau_{Ysi} = 0$ $\tau_{Ksi} = 0$	(3) $\tau_{Ysi} = 0$
Interquartile range	3.935	4.024	3.871
25th percentile	15.266	15.173	15.333
75th percentile	19.201	19.198	19.204
Output share of largest 0.01% of establishments	39.13%	58.93%	47.16%
Output share of largest 0.1% of establishments	76.17%	86.86%	81.38%
Output share of largest 1% of establishments	95.38%	97.93%	96.63%
Output share of largest 5% of establishments	99.03%	99.62%	99.31%
Output share of largest 10% of establishments	99.59%	99.84%	99.71%
Output share of largest 20% of establishments	99.86%	99.95%	99.90%
Output share of smallest 1% of establishments	0.00000%	0.00000%	0.00000%
Output share of smallest 5% of establishments	0.00003%	0.00001%	0.00003%
Output share of smallest 10% of establishments	0.00014%	0.00004%	0.00012%
Output share of smallest 20% of establishments	0.00075%	0.00024%	0.00058%

Table 6: TFPGAP and Hypothetical Establishment-Size Distributions for Subperiods

	1981-2008 (Baseline)	1981-89	1990-99	2000-08
Actual size distribution				
Interquartile range	3.935	2.635	2.992	3.586
Output share of largest 1% of establishments	95.38%	79.66%	92.26%	90.36%
Output share of smallest 20% of establishments	0.001%	0.04%	0.004%	0.002%
Output distortions and capital distortions=0				
$TFPGAP$	0.717	0.733	0.716	0.701
$TFPGAIN$	39.56%	36.42%	39.67%	42.71%
Interquartile range	4.024	3.009	3.316	3.919
Output share of largest 1% of establishments	97.93%	82.97%	94.03%	95.73%
Output share of smallest 20% of establishments	0.000%	0.017%	0.002%	0.000%
Output distortions=0				
$TFPGAP_{capital}$	0.826	0.838	0.832	0.808
$TFPGAIN_{capital}$	21.05%	19.32%	20.25%	23.77%
Interquartile range	3.871	2.586	2.970	3.609
Output share of largest 1% of establishments	96.63%	79.73%	93.22%	92.66%
Output share of smallest 20% of establishments	0.001%	0.040%	0.004%	0.001%

Table 7: TFPGAP and Hypothetical Establishment-Size Distributions under Alternative Specifications

	(1) Baseline	(2) 1981-2000 and 2005	(3) Trimming $\pm 2\%$	(4) $\sigma = 6$
Actual size distribution				
Interquartile range	3.935	3.640	3.887	1.816
Output share of largest 1% plants	95.38%	95.40%	94.14%	51.35%
Output share of smallest 20% plants	0.001%	0.001%	0.001%	0.606%
Output distortions and capital distortions=0				
TFPGAP	0.717	0.722	0.760	0.732
TFPGAIN	39.56%	38.49%	31.63%	36.67%
Interquartile range	4.024	3.751	3.944	2.161
Output share of largest 1 % plants	97.93%	97.14%	97.09%	64.44%
Output share of smallest 20 % plants	0.0002%	0.001%	0.000%	0.247%
Output distortions=0				
TFPGAPcapital	0.826	0.832	0.866	0.913
TFPGAINcapital	21.05%	20.16%	15.48%	9.50%
Interquartile range	3.871	3.565	3.825	1.831
Output share of largest 1 % plants	96.63%	96.25%	95.52%	57.35%
Output share of smallest 20 % plants	0.0006%	0.001%	0.001%	0.543%

Table 8: Probit Estimation of Exit Probability

	Marginal Effect	Robust Std. Err.
$log(Adjusted\, TFPR_{st})$	-0.013	0.004***
$log(TFPQ_{si}/TFPQ_{s})$	-0.027	0.003***
$log(1-\tau_{Ysi})$	-0.022	0.005***
$log(1+\tau_{Ksi})$	0.013	0.001***
$log(age)$	-0.021	0.004***
$(log(age))^2$	-0.006	0.006
$(log(age))^3$	0.003	0.003
$(log(age))^4$	0.000	0.001
constant		
year dummy	Yes	
industry dummy	Yes	
Number of Obs.	2612536	
Pseudo R-squared	0.0787	

Notes.
1. The dependent variable is a dummy that takes one if the establishment exits in year t and zero otherwise.
2. All the dependent variables are one-year lagged values.
3. *** indicate statistical significance at the 1% level. Standard errors are adjusted for clustering at the industry level.

Table 9: Estimation Results of a Random-effect Model of Industry-level Entry Ratio

	Coef.	Std. Err.
$Adjusted\, TFPR_{st}$	-0.0002	0.00008***
Constant	0.2029	0.01462***
Year dummy	Yes	
Industry dummy	Yes	
Number of obs.	1001	
R-squared within	0.4105	
R-squared between	1	
R-squared overall	0.5252	

Notes.
1. The dependent variable is a share of entrants in all the establishments.
2. *** indicate statistical significance at the 1% level.

Table 10: Estimation Results of the Establishment-level TFPQ Growth Rate Subsequent to Entry

Period	1981-2008			1981-2000		
	Coeff.	Std. Err.		Coeff.	Std. Err.	
$TFPQ_{si}/TFPQ_s$	-0.0560	0.001	***	-0.0534	0.001	***
τ_{Ysi}	-0.0112	0.000	***	-0.0108	0.000	***
τ_{Ksi}	-0.0004	0.000	***	-0.0005	0.000	***
Constant	-0.138	0.007	***	-0.1397	0.007	***
Year dummy	yes			yes		
Industry dummy	yes			yes		
Number of obs.	328996				316293	
F(81,328901)	494.38				510.24	
Prob > F	0				0	
R-squared	0.1085				0.1054	
Adj. R-squared	0.1083				0.1052	
Root MSE	0.4055				0.40552	

Notes.
1. The dependent variable is the establishment-level TFPQ growth rate subsequent to entry.
2. The dependent variables are values at the entry.
3. *** indicate statistical significance at the 1% level.

Table 11: External Dependence Ratio by Industry

	JIP industry classification	External dependence ratio
38	Smelting and refining of non-ferrous metals	0.705
31	Coal products	0.679
18	Pulp, paper, and coated and glazed paper	0.656
30	Petroleum products	0.643
24	Basic inorganic chemicals	0.616
39	Non-ferrous metal products	0.596
33	Cement and its products	0.595
21	Leather and leather products	0.587
51	Semiconductor devices and integrated circuits	0.582
13	Beverages	0.581
25	Basic organic chemicals	0.577
32	Glass and its products	0.571
26	Organic chemicals	0.568
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.565
56	Other transportation equipment	0.558
23	Chemical fertilizers	0.548
8	Livestock products	0.546
37	Miscellaneous iron and steel	0.542
43	Special industry machinery	0.536
46	Electrical generating, transmission, distribution and industrial apparatus	0.534
49	Communication equipment	0.527
12	Prepared animal foods and organic fertilizers	0.525
36	Pig iron and crude steel	0.516
54	Motor vehicles	0.511
22	Rubber products	0.510
16	Lumber and wood products	0.486
35	Miscellaneous ceramic, stone and clay products	0.480
27	Chemical fibers	0.477
34	Pottery	0.468
28	Miscellaneous chemical products	0.468
11	Miscellaneous foods and related products	0.460
15	Textile products	0.450
58	Plastic products	0.449
53	Miscellaneous electrical machinery equipment	0.435
55	Motor vehicle parts and accessories	0.431
47	Household electric appliances	0.399
42	General industry machinery	0.394
57	Precision machinery and equipment	0.380
44	Miscellaneous machinery	0.351

Table 11: External Dependence Ratio by Industry, continued

	JIP industry classification	External dependence ratio
19	Paper products	0.348
40	Fabricated constructional and architectural metal products	0.343
10	Flour and grain mill products	0.337
29	Pharmaceutical products	0.324
45	Office and service industry machines	0.322
20	Printing, plate making for printing and bookbinding	0.300
41	Miscellaneous fabricated metal products	0.264
59	Miscellaneous manufacturing industries	0.248
17	Furniture and fixtures	0.166
50	Electronic equipment and electric measuring instruments	0.131
9	Seafood products	-0.064
92	Publishing	-0.134

Table 12: Estimation Results for the Establishment-level Distortions: 1981-2008

	(1) $TFPRGAP_{sit}$	(2) τ_{Ysit}	(3) τ_{Ksit}	(4) τ_{Ksit}
External finance dependence	0.782	1.088	1.329	1.343
	(0.227)***	(0.366)***	(0.683)*	(0.684)*
Log (age)				-0.185
				(0.026)***
Log($TFPQ_{si}$)	0.171	0.404	-0.202	-0.200
	(0.043)***	(0.096)***	(0.071)***	(0.071)***
Regulation index	0.211	0.297	-0.005	-0.003
	(0.134)	(0.280)	(0.372)	(0.373)
Log(number of employees)	-0.103	-0.203	-0.433	-0.415
	(0.037)***	(0.082)**	(0.093)***	(0.093)***
Corporation dummy	0.005	-0.201	0.760	0.756
	(0.054)	(0.123)	(0.168)***	(0.166)***
Sole proprietorship dummy	-0.252	-1.092	2.073	2.055
	(0.058)***	(0.156)***	(0.255)***	(0.252)***
Share of workers aged 20-29	14.266	22.611	-11.689	-11.501
	(4.689)***	(9.350)**	(19.155)	(19.104)
Share of workers aged 30-39	12.656	22.508	-19.383	-19.080
	(5.193)**	(10.051)**	(14.374)	(14.368)
Share of workers aged 40-49	13.636	20.985	-5.840	-5.750
	(4.863)***	(9.569)**	(17.023)	(16.984)
Share of workers aged 50-59	16.256	29.151	-28.049	-27.598
	(4.992)***	(9.886)***	(15.567)*	(15.543)*
Share of workers aged 60+	14.060	25.535	-16.444	-15.857
	(4.846)***	(9.488)**	(16.681)	(16.647)
Share of part-time workers	-0.145	-0.471	2.360	2.304
	(0.500)	(0.947)	(1.929)	(1.924)
Constant	-14.384	-27.361	19.104	18.784
	(4.603)***	(8.874)***	(15.399)	(15.374)
Year dummy	yes	yes	yes	yes
Number of obs.	3336281	3332638	3324795	3324795
R-squared	0.2654	0.3204	0.0576	0.0585
Root MSE	0.45403	0.96344	4.0105	4.0086

Notes.
1. *** and ** indicate statistical significance at the 1% and 5% level, respectively.
2. Numbers in parentheses are standard errors adjusted for clustering at the industry level.
3. Corporation dummy and sole proprietorship dummy are compared with cooperatives and other corporations.

Table 13: Estimation Results for the Establishment-level Distortions: 2001-2008

	(1) $TFPRGAP_{sit}$	(2) τ_{Ysit}	(3) τ_{Ksit}	(4) τ_{Ksit}
External finance dependence	0.505	0.643	0.458	0.457
	(0.285)*	(0.427)	(0.506)	(0.506)
Log (age)				-0.152
				(0.021)***
Log($TFPQ_{si}$)	0.175	0.318	-0.151	-0.151
	(0.046)***	(0.082)***	(0.043)***	(0.043)***
Regulation index	0.076	0.087	0.034	0.026
	(0.171)	(0.303)	(0.211)	(0.211)
Export dummy	0.051	0.116	-0.156	-0.159
	(0.013)***	(0.024)***	(0.042)***	(0.042)***
Log(number of employees)	-0.123	-0.176	-0.189	-0.157
	(0.045)***	(0.083)**	(0.059)***	(0.061)**
Corporation dummy	0.036	-0.156	0.640	0.632
	(0.074)	(0.131)	(0.102)***	(0.104)***
Sole proprietorship dummy	-0.204	-1.088	1.720	1.635
	(0.078)**	(0.177)***	(0.153)***	(0.154)***
Share of workers aged 20-29	37.068	61.612	5.467	6.255
	(12.069)***	(21.961)***	(21.877)	(21.832)
Share of workers aged 30-39	22.715	33.657	16.042	17.023
	(10.574)**	(18.228)*	(19.218)	(19.046)
Share of workers aged 40-49	41.071	64.954	4.380	5.163
	(13.165)***	(23.617)***	(22.021)	(21.992)
Share of workers aged 50-59	31.156	48.637	7.860	8.965
	(12.056)**	(21.109)**	(20.137)	(20.014)
Share of workers aged 60+	30.888	50.268	6.816	7.762
	(10.782)***	(19.337)**	(20.031)	(19.948)
Share of part-time workers	-0.341	-1.041	2.436	2.358
	(0.896)	(1.459)	(1.284)*	(1.283)*
Constant	-32.888	-54.408	-5.587	-6.222
	(11.449)***	(20.332)**	(19.956)	(19.858)
Year dummy	yes	yes	yes	yes
Number of obs.	366079	365500	363190	363190
R-squared	0.2688	0.2764	0.0323	0.0355
Root MSE	0.44794	0.80126	2.4094	2.4055

Notes.
1. *** and ** indicate statistical significance at the 1% and 5% level, respectively.
2. Numbers in parentheses are standard errors adjusted for clustering at the industry level.
3. Corporation dummy and sole proprietorship dummy are compared with cooperatives and other corporations.

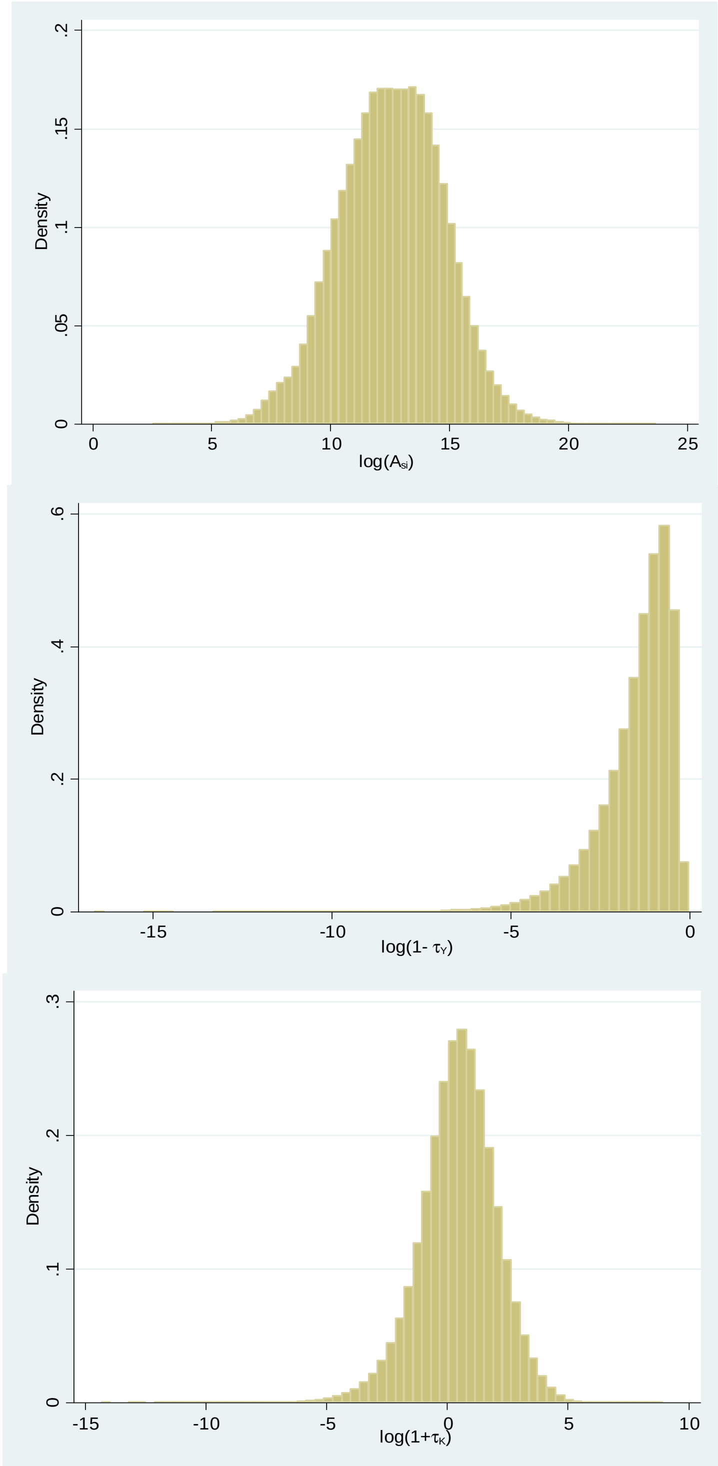

Figure 1: Density of $log(A)$, $log(1-\tau_Y)$, and $log(1+\tau_K)$

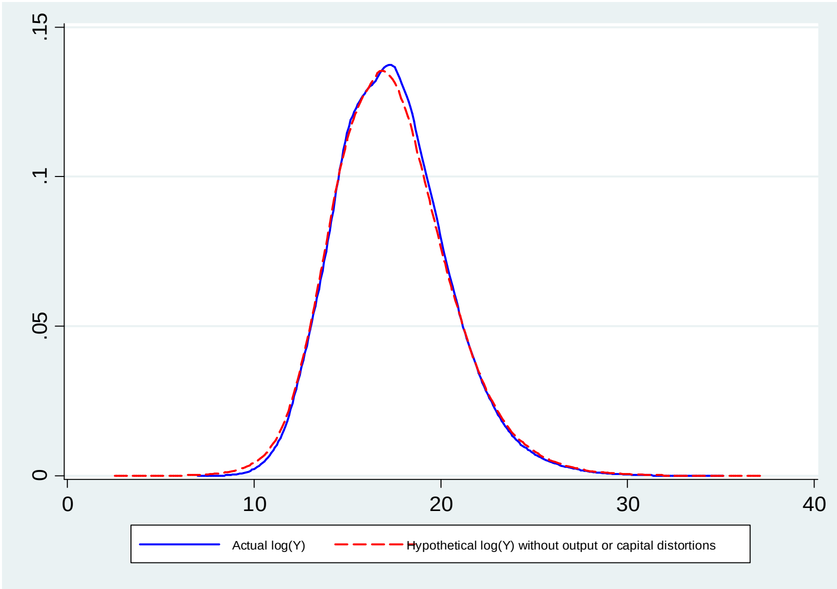

Figure 2: Density of Actual $log(Y_{si})$ (Blue Line) and Hypothetical $log(Y_{si})$ for $\tau_{Ysi} = \tau_{Ksi} = 0$ (Red Line).

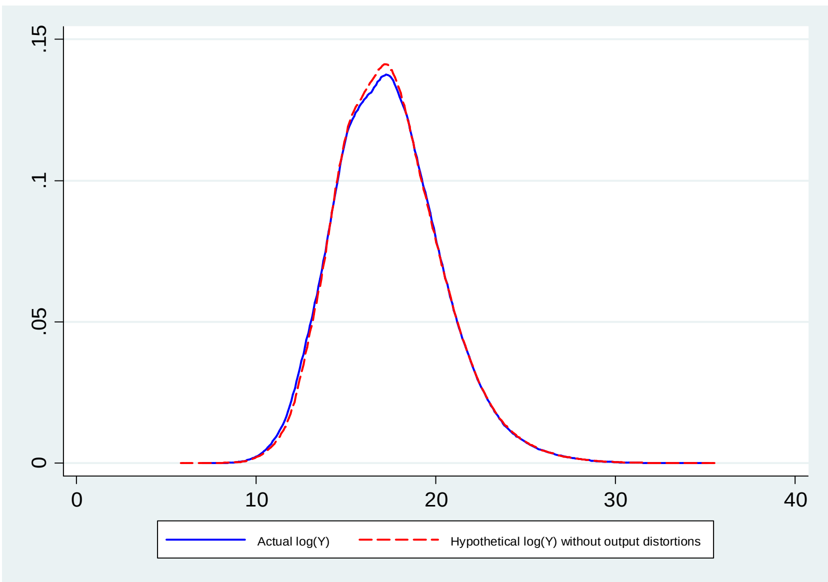

Figure 3: Density of Actual $log(Y_{si})$ (Blue Line) and Hypothetical $log(Y_{si})$ for $\tau_{Ysi} = 0$ (Red Line)

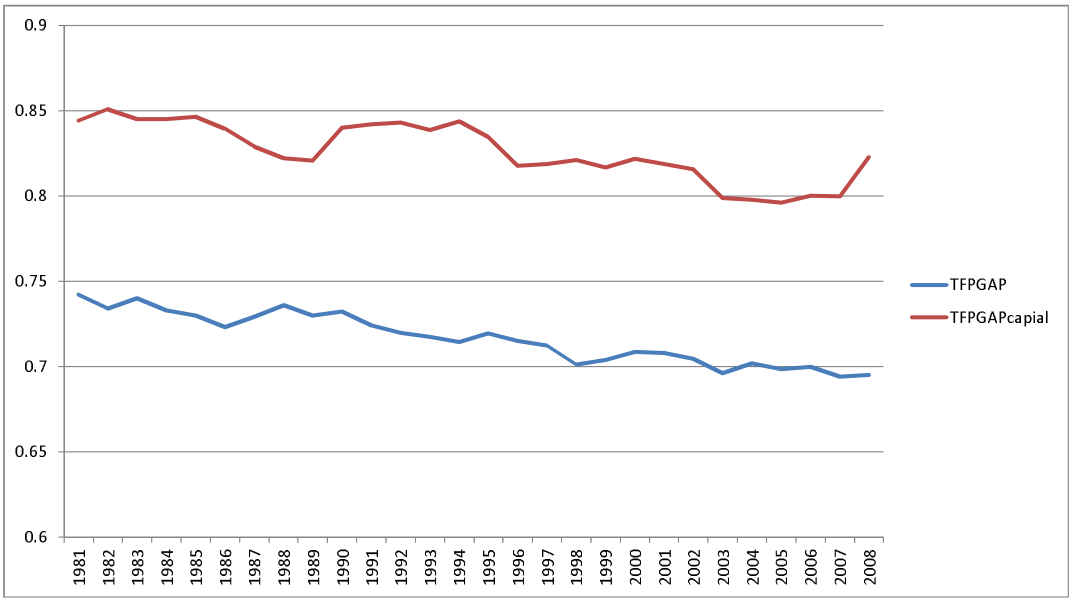

Figure 4: $TFPGAP(\tau_{Ysi} = \tau_{Ksi} = 0)$ and $TFPGAP_{capital}(\tau_{Ysi} = 0)$

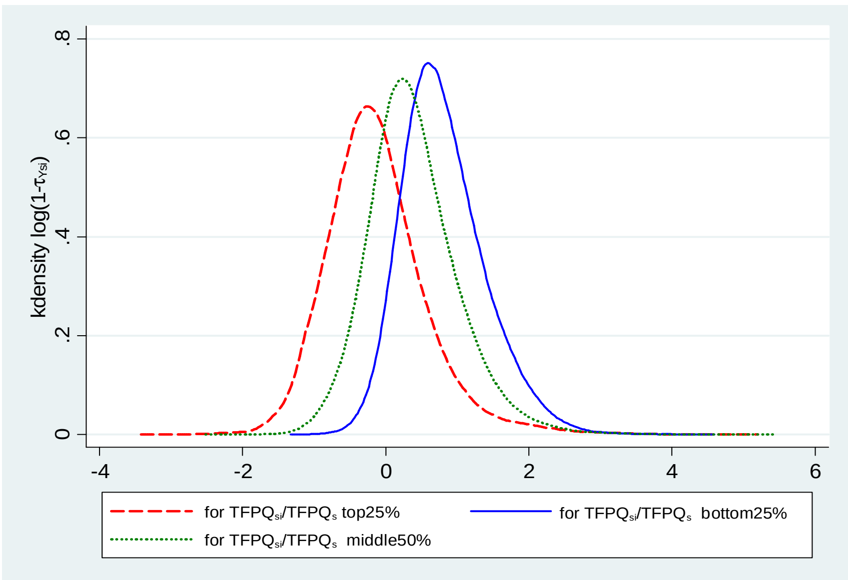

Figure 5: Density of $log(1 - \tau_{Ysi})$ for the establishments with their $TFPQ_{si}/TFPQs$ lie in the highest quartile (red, dashed line), the second and third quartiles (green, dotted line), and the lowest quartile (blue, solid line).

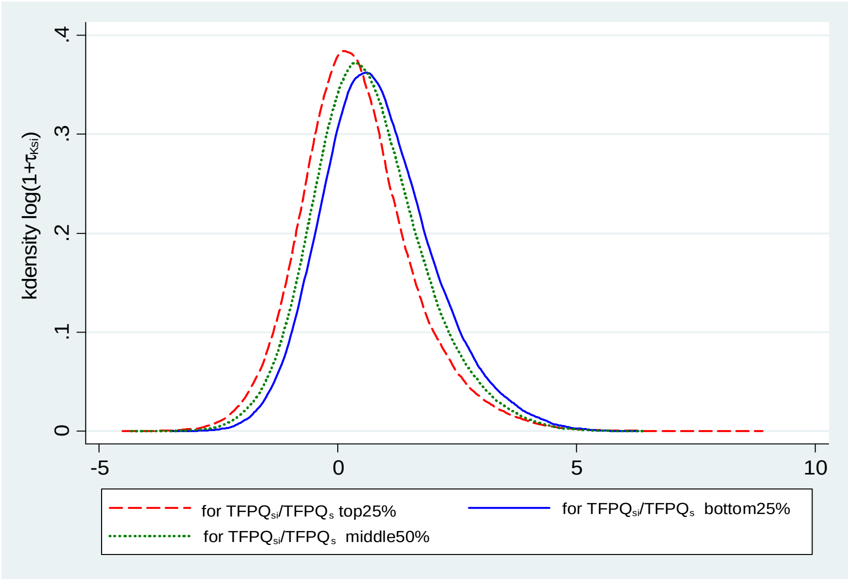

Figure 6: Density of $log(1 + \tau_{Ksi})$ for the establishments with their $TFPQ_{si}/TFPQs$ lie in the highest quartile (red, dashed line), the second and third quartiles (green, dotted line), and the lowest quartile (blue, solid line).